

DI Math Seminar

The Art of Beading Using MATH

James Jones

Diné Institute for Navajo Nation Educators (DINÉ)

2021

Author Notes:

James Jones is a Diné Language and Culture teacher at Mount Elden Middle School in Flagstaff Arizona. Correspondence about this curriculum unit can be addressed to James Jones 3223 N Fourth St, Flagstaff, AZ 86004. Email contact: jjones1@fUSD1.org

Our Vision: Succeed to Lead

Our Mission: Mount Elden Middle School exceeds expectations with innovative approaches that honor diversity and culture to ensure each student's success.

MEMS provides a wide variety of programs and classes that focus on college and career readiness. Our students take core classes in math, language arts, social studies, and science, and our science department has begun the transition to the Next Generation Science standards. In addition to core classes, MEMS also offers specialized academic programs including the APEX Academy, Alpine Leadership Academy and Heartwood. Click here to learn more information about our specialized programs!

At MEMS students are also given a large variety of electives to choose from. Class offerings vary depending on the grade level and faculty availability. Our electives at MEMS includes Band, Choir, Orchestra, Foods, Woods, Art, P.E., Technology, Spanish, Navajo, Leadership and Theater!

*We invite you to be our guest at Mt. Elden Middle School.
Please come and see the great things our students are doing! (MEMS website)*

Context

Mount Elden Middle School, or MEMS, along with one other middle school, is part of the Flagstaff Unified School District. The school started as the only middle school called Flagstaff Middle School since 1960's. The school has enrollment about 800+ diverse students (Anglo, Hispanics, African Americans, Native Americans, and other nationalities). The school has grades from 6th, 7th, and 8th grade. The school has about 90 staff employed, including administration, teachers, para professional, admin, cooks, and janitors. Over the years, the school has expanded by adding another building to add more classrooms to accommodate the increasing enrollment of students. During these years of changing, the school also changed its name to Mount Elden Middle School.

Students who attend MEMS come from different surrounding areas of Flagstaff like Kachina Village, Mountaineer, Doney Park, Munds Park, Parks, Lake Mary area, Mormon Lake, Belmont, and small communities from the nearby Navajo reservation like Luepp, Birdsprings, Dilkon, Cameron, Tolani Lakes, etc. The students at MEMS come to school within a 90-mile radius either by bus or other means of transportation.

Over the years each of the grades (6th, 7th, and 8th) had different enrollments so the student-teacher ratio had a steady ratio of 25-1. Because of that there were multiple classes with the same subjects, just to balance out the student enrollment. More recently programs were created where students can select their interested program at their grade level and also, they can choose their electives but their core classes have been selected for them.

At MEMS, one of the electives (included as an option as part of the language requirement for 8th graders), is the Navajo Language class. This class was reintroduced to the school after a three-year absence, due to the fact that the previous Navajo teacher and the program moved to another middle school, Sinagua Middle School. Navajo students along with student council made efforts

to request the administration to bring back the Navajo language to MEMS. The reason for this request was that the only other language class that students took was Spanish. For the school year 2019-2020, Navajo class was reintroduced and was offered and, for the first time after three years, teachers, administrators, and students were able to hear Navajo language being spoken again in the classroom.

At MEMS, Navajo language was taught according to the students' outcome on the pre-assessment call DOLPA (Diné Oral Language Proficiency Assessment), an assessment created by the Navajo teachers at Puente de Hozho Elementary School. Some students, who are new to the language, have struggled because students did not have as much exposure to the language at their previous elementary school. Students in the Navajo classes admitted that they knew the basic terms and meanings, and one to two-word conversations like yes, no, colors. Another factor to their struggles was that they came from other elementary schools within the school district, where they were taught simple Navajo language for example: basic animals, numbers, and basic questions and answers and not so with writing or reading in the language either. The Navajo culture / traditions were taught, but instructions and activities were in the English language, but then again with just the basic Navajo language.

The students that came into the Navajo class in 2019, were either in any of the two classes. 6th and 7th graders were in the Intro to Navajo class while the 8th graders were in Navajo 1. Since this was new to both the teacher and the students, both classes were taught the same lessons. There was a Navajo assessment that was given and the students did not perform well. 99% could read the story given to them, but two results 1) students were mono tonal, meaning students could not hit the nasal or the high tones as Navajo words require, 2) students did read the words but had no comprehension as to what was read. Students were given a mix of basic Navajo words from kindergarten to high school, and the results were that some students (about 30%) were able to understand the words.

After seeing the results of the assessment, appropriate modifications were made to ease student work. These modifications include teaching the basic Navajo phonetic sounds, learning Navajo alphabets and numbers, and basic Navajo conversation. The Navajo conversation places the verb at the end of the sentence and does not follow the English subject-verb agreement. Students had to learn about the basic but different viewpoints (position of the person) when using verbs in a sentence. The main focus was that the students had to hear the language 95% of the time in class while the 5% was on translating back to English for students to understand. This was not an easy task because some students did not have support at home.

The administration and other teachers were and are excited that Navajo language/ culture and tradition has been revived back at the school. The Navajo classes have begun in the fall of 2019, and there was a sense of differences in the students' behavior and attitude. A sense of pride and positive behavior has been seen within the Native American students representing different tribes, not only because the Navajo language can be heard though the hallways again but their teacher is also the one of two Native Americans employed at the school. And also, there has been a sense control or some sort of order where students are reminded of their actions.

Rationale

When I look at a bead work and it makes me wonder what kind of math was applied to their design. I see geometrical patterns of triangles, squares, trapezoids, and circles. Sometimes the shapes are combined to represent animals (like bears, eagles, horses, etc.) or of nature (like mountains, hills, sun, moon, etc.) and of traditional homes like teepees or hogans or anything like that. Over the years I have begun to understand about colors and why certain shapes are used with colors. For example: color red means hardship or blood, white means purity, yellow means achievements or something like that, black and blue means coming out from a dark place that you are now coming out from. And then there are shades of morning or evening colors or sky or earth tone colors.

In historical times, Native bead work or art work with repetitive patterns told a story of important family histories or a tribe's great hunt, or telling of a great battle that resulted in victory. Sometimes the bead work also meant a great dream or vision. Some families have handed down beaded artifacts that came from their ancestors and they still tell their family stories.

When you look closely at bead work, the designs have interesting math designs dealing with shape and color patterns. The designs are numbered in 5s or 9s, but in odd numbers because of symmetry length and width. And with colors the number varies in even or odd numbers. But if colors are used sometimes, it's in single numbers depending on solid or shades of color.

Math has been my weakest area through-out my school years. I think C+ was my average grade. But geometry and algebra were my strongest because they involved art or some sort of art or designs and patterns. Drawing with graphs and shapes were fun, but I struggled with numbers and to this day, I still do. I know what some of my students going through with math and I try my best to help them. But these same students also have an artistic side. I tell them that art is like math. You have your skills to make an art piece, you add, you subtract (erase), multiply, or divide and the answer is the finish an art piece. I share this metaphor with my students and sometimes they get the "aha" moment and sometimes it takes longer.

My students also like to design things with their computer programs. Some students have impressed me with their work using computer graphics. I tell them that they have a very unique way of applying math to their artwork that they have done. I tell my technology savvy students that they did math work without even thinking about it.

Building on experiences in mathematics and art, students will learn that the grandmothers and grandfathers learned about object patterns and numerical patterns even though they never went to school. The students will see pictures of bead work that were done in the 1800's to present time. The students will also know that bead work then was about family history, dreams, or storytelling and using only certain colors, but now the meanings may have changed because people have access to more colors and have developed different styles of beading. This research will help understand that the elders had a universal communication and understanding about each other.

Through research and media, students will also realize that there are some people who have an artistic side of creating some of the most detailed and beautiful bead work and because of their

work, they that have been recognized for their talent. One such place is a museum in Eugene, OR, where the items are displayed were all beaded. The beaded items were done by many people within the area of Eugene or within the state of Oregon. Beading is also a source of income for many people. They bead in any style like rope style, peyote stitch, loom (wide or narrow), etc. do bead, and bead for a living meaning that they sell what they make like beaded hairpins, pens, lanyards, earrings, etc. It is a competitive art form because the complexity in designs. But then some buyers would prefer a much simpler design that would go with their choice of fashion or hair styles. Either way people buy and sell beaded items. Student will do research about why beaded items cost a certain price, this will be based on location of beads being sold, kinds and types of beads, cost of needles, threads, and other items to make an item and then time and labor included. Students will research on people who bead in a particular style and interview them.

For me, it is personal. I want to learn and do my own patterns using various colors. I want to bead my own hair pins for my dancing or for others, bead stuff to challenge my mind, and just to do them for fun create another hobby.

Teaching this unit can make the students appreciate math and understand it. According to the NCTM (2003) mathematics is often described as the “science of patterns.” Developing a solid understanding of patterns in earlier grades can actually help students do well as they move into topics related to functions and equations in Algebra and beyond. It is also a recognizable skill in and of itself in that it helps students create connections across mathematical representations and visualizations. “Awareness of the structure of patterns...can facilitate the learning of many mathematical concepts,” (Mulligan & Mitchelmore, 2009, p. 35). Being able to describe a pattern they see or create in terms of both stasis (what they observe) and change (how the pattern could be expanded) is an important skill that later connects to the notion of a function (NCTM, 2003). They will also know that math is everywhere in what they do in life and that with this pattern unit they will be telling their own story about Native math (Barta and Eglash, 2009).

Content Objectives

My summers at my grand-parents place were special. Special because that is where I learned some basic survival skills about natural harvesting and gatherings of plants for food and medicine. My grandfather used to help some medicine men that did sandpainting and he used to tell me about the patterns of the figurines. The figurine patterns were repetitive but in different colors representing the four sacred colors. The sand paintings were very detailed and without using any type measuring tools the pictures were symmetrical. The medicine man would talk about patterns in songs, prayers, and in drawings. However, they also warn that making the drawings takes time to perfect and there should be no flaws. He also talked about the ancient drawings on potteries and rock art. He said that there are repetitive patterns that tell stories. I will not forget that day because he told the men that were helping to follow what he was doing. He showed them how to place the sand in their hands and then how to sprinkle sand. So, he made everyone practice that before they started on the sandpainting. But there was one man who messed up and the medicine man caught him and scolded him. The man was asked to leave because he was not following directions. The medicine man and also some people who bead that I have talked to have mentioned that shapes are in odd numbers because the middle number determines balance in nature, the universe, and the elements of life.

My grandparents never went to school but they were great teachers, and the way they taught us grandkids are similar to the teachings we teachers do in the classroom. They taught using guided practice, think-pair-share, lots of feedback, and I do We do You do. Their objectives were simple, watch and learn and use the skills that were taught, we should be able to teach others or our children and what they learn will be useful for them. Their simple teaching strategies made us learn skills that have help me in the classroom. Back in the years there were no advance electronics like we do now, to show us how to do things hands on and to make sure that we store the teachings in our long-term memory. I once heard that the Native Americans are the best mathematicians or chemist along with intense one on one instructions.

My content objectives will be based on critical thinking and hands on learning. In the Navajo philosophy of learning, there are four teachings: Thinking, Plan, Life, and Harmony. In the first step of this lesson is thinking and my students will start with critical thinking. We will be thinking about the math, the patterns, and the skills about beading. Part of this will include simply being able to describe what they see in a beaded pattern. What colors are used, what numbers of beads are used, and how changes in colors and numbers of beads can create a visually meaningful pattern (stasis). Students will also be asked to think about how they can extend a pattern. What might come next, in terms of color and/or numbers of beads, will help students think about expanded or repeating what they see (change). Then using various teaching skills / strategies we will begin planning our projects on paper and using technology for media and softwares that were developed for beading. Once our plans are in place then will do our projects. The result of the lesson will be a beaded loom or a cylinder object beaded using peyote stitch. During this lesson we will learn how to give feedback, how to support each other, and how to have fun. By doing this also, my students will learn to appreciate social skills, appreciate self-control, and learn about the art and history about the meanings of the designs.

I am reading and watching videos about beading on a loom and peyote stitching. I am experimenting the hands-on stitching and trying to get comfortable so that I am able to teach my students how to do their beading projects. I have been briefly talking with people who bead for a living (and they also have agreed to talk to my students either on person (if allowed) or by zoom.

- Students will look at weaving patterns to inform their development of beading patterns.
- Students will create a beading pattern that applies repeated or growing patterns.
- Students will create and describe their own beading pattern in terms of both stasis (describe the pattern as it exists) and change (describe the pattern in terms of what comes next).
- Students will be able to describe and explain their color choices and pattern in terms of the pattern's connections to Navajo beading characteristics.

Teaching Strategies

The unit will employ a variety of teaching strategies to engage students in the exploration of patterns and in using various formats (e.g. technology, physical manipulatives, etc.) to create, share, and investigate patterns.

KWHL Charts

This chart will be used 3 times during the unit lesson instruction 1) lesson / activity on beading history. This chart will help the student learn more about their activities online research and hands on activities. Teachers know what KWL is K-What do I KNOW, W-What do I WANT to know, L-What did I LEARN? And this has been used for many various activities or lessons. But for these particular lessons and activities, I will be using the KWHL chart. KWHL is K-What do I KNOW, W-What do I WANT to know, H- HOW will I learn? L-What did I LEARN? There will be an extra column for H (HOW will I learn?). The student will indicate how they are going to learn about their beading unit. For example, the student will indicate that they will learn how to make patterns using technology software by using y and x grid, or making patterns using paper grid paper, or making patterns using peyote stitching. They will make notes about what they did or what their plans are.

Analyzing patterns

The teacher will ask students to look at several weaving patterns and describe the pattern in different ways (e.g. stasis versus change), then have students connect weaving patterns to their beadwork.

Think-pair-share

Students will make plans and begin to start how they will research their beading project. They will plan a step-by-step information on all of their 3 beading projects. They will share their beading ideas with the teacher and the class. The students will be encouraged to use their KWHL chart and the student will fill in the first two sections of the KWHL, the K and W. After they have revised their plan then they will work on the H part of the KWHL. The H will give the student a more focus about their research. Students will gather feedbacks about their project and they will need to make any changes.

The students will be using various resources when they do think pair share. For example: When students watch any media videos from (You-Tube, Vemo, Instagram, etc) they will share with the class or group and have discussions about the videos. When they take notes during a presentation and share their insights about the presenter.

Interviews and Guest speaker/videos

Students learn from the experts. There are guest speakers who will be sharing how they use math to create their beading patterns. The guest speaker will talk about their preferred specialty in beading styles and they will also talk about their history about how they learned and what they learned about their beading style. This is so the students can get comfortable with the guest speaker. These guest speakers will be either in-person or by ZOOM. Students will be interacting with the guest speaker about how to start on their projects. All students will be starting their projects from the beginner's level. However, students can also do an individual interview on their own. They do need to share their information with the teacher and students

Student can view videos and share with their class. The video will help with the step-by-step process and the videos watched can be viewed individually and at any time for more in-depth knowledge.

Group work and independent work

For the math lessons and guest-speaker's presentations, the assignments will be group work because they will be sharing information and ideas with each other.

For the independent work it will be on the technology software activity, the grid paper activity, and the individual peyote stitch project.

Classroom Activities

Student activities are highlighted below in the context of several daily lessons.

Lesson 1- Beading with Math is fun (Pixel Art)

Objective: Students will be able to

- 1) Learn the history of beading among Native Americans from oral history or written history of where and how beading originated.
- 2) Learn about how beading became part of the Navajo arts and crafts.
- 3) Students will be able to do a Pixel Art using graph paper.

Procedure:

To start off with this unit teacher will be introducing the lessons on beading in graphing, computer graphics, and hands on stitching.

Overall lesson description:

The overall lesson of this unit is about Native American beading and how math is involved in counting, patterns, geometry, perceptions, etc. The lesson will also cover AZ state math standards as well as Navajo Nation educational standards. There will be a pre and post student assessments when the unit lessons are done. The different parts of the lessons will have a presenter and or a virtual zoom presenter explaining their style of beading which will include the history of that style, how they incorporate math into their designs, and the enjoyment of their beading. The students will have two online articles to read "Native American Beadwork" (<https://www.kshs.org/kansapedia/Native-american-beadwork/17880>) and "Native American Beadwork | Traditional Beading History, Patterns & Styles" (<https://www.powwows.com/Native-american-beadwork-a-rich-history-of-cultural-techniques/>).

After reading the articles, students will be able to answer the following questions.

- What do colors mean?
- What do symbols mean?
- What math pattern designs will be used?
- Will the design change from a loom form to peyote stitch?

This lesson will have three activities that the students will do and each lesson will have a sub post assessment.

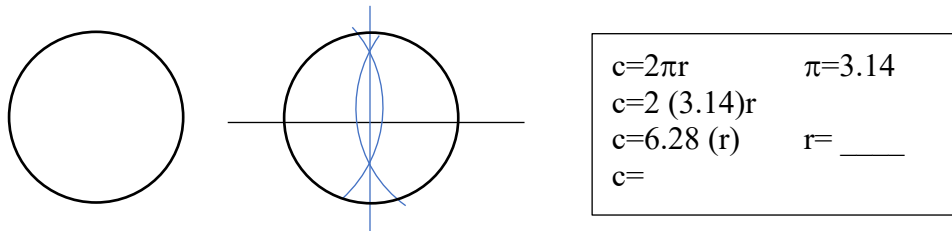
Lesson 2: Calculating Circumference and measuring a pony bead.

Objective:

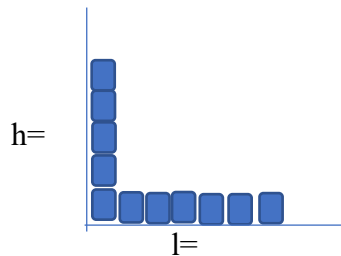
- 1) Students will use the geometric circle circumference formula to find out the measurement of a 16.9 fl.oz. water bottle.
- 2) Students will measure the size of a pony bead using the metric system.

Procedure:

Teacher will give each student a water bottle. Student will then draw an outline of the bottle as closely to the edge as possible. The they will redefine the circle by measuring the circle with a compass. Teacher will model the steps and students will follow the instructions. Teacher will also model how to do line bisecting. Students will need to find out the measurement for r



When done then students will measure the pony bead and find out how many beads will fit the measured height and how many for them to go around.



When done with the calculations then the student will get a blank peyote stitch graph paper and students will count the number of beads needed for height and length. After making the calculations then the students will begin making their designs. Students will need to make three different designs and then choose one that they will do for their final project. The graph paper will be found at this website, <https://artbeads.com/printable-seed-bead-graph-paper-free-designer-download/>

Peyote Stitch

W/ROUND BEADS

ARTBEADS SEED BEAD GRAPH PAPER / HOORAY FOR HANDMADE!

The image shows a grid of beads for Peyote stitch. The grid is 20 beads wide and 20 beads high. The top and bottom rows are labeled with numbers 100, 99, 98, 97, 96, 95, 94, 93, 92, 91, 90, 89, 88, 87, 86, 85, 84, 83, 82, 81, 80, 79, 78, 77, 76, 75, 74, 73, 72. A text box on the left side of the grid contains the text: "Find number of beads needed for height".

Find number of beads needed for height

Find number of beads needed for length.

The final sub assessment. Student will make three different designs and choose one for their final project.

Lesson 3: Virtual Beading Loom

Lesson objective:

- 1) Students will be able to do a Pixel Art using virtual loom software.
- 2) Student will be able to use graphing coordinates to make their design using virtual beading loom software.

Materials needed:

4x4 graph paper (two or three per student)

Coloring pencils (no markers or crayons)

Pencil / pen

Lesson procedure:

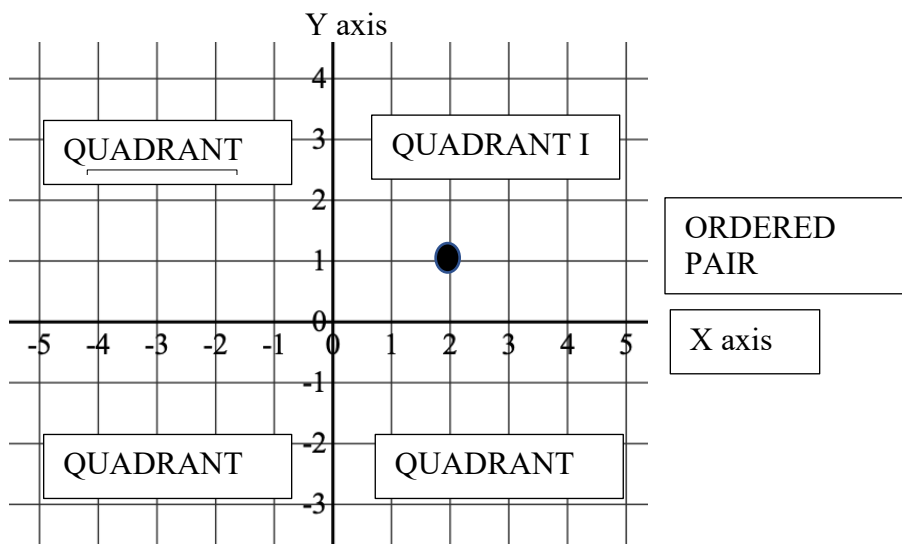
Teacher will distribute two or three graph paper (4x4 preferred) to each student. Student should have the coloring pencils with them.

Teacher will introduce the lesson on Pixel art using graph paper. Using a poster size graph paper, teacher will make some examples about what pixel art is about using each small squares for different colors. Before the students start on their work, they must find the center point of their graph paper so that they know where they will start.

Teacher will introduce graphing lesson and introduce new vocabulary words. Teacher will hand out graph paper that will have the 4 quadrants with labels. Teacher will go over each section and explain and model how to use the grids using paired coordinates.

Graph paper will be obtain from math-drills.com. (<https://www.math-drills.com>)

Vocabulary: Quadrants, point, paired coordinates, x axis, yaxis



Students will practice with some given coordinates and then teacher will direct them to this website (<https://csdt.org/culture/beadloom/index.html>). Students will be instructed to click on the tap software and click on mathematics. Students' task will be to copy their design from paper to the virtual loom. Students' sub assessment will be a complete copy of their design and to take a screenshot of their virtual work.

Lesson 4: Final project

Objective:

- 1) Students will use their paper design project to actually bead their water bottle.

Lesson Procedure:

Students will get their pony bead colors for their final project. They will also have needles and kite string (about 3 yards). They will get their water bottles. Teacher will give each student the website about how to start the peyote stitch for circular objects.

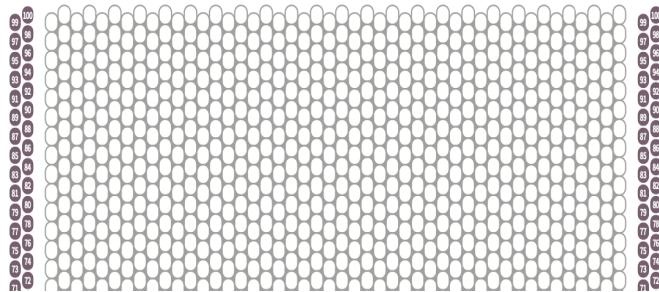
(<https://www.interweave.com/article/beading/how-to-peyote-stitch/>) and teacher will also have an example of the project.



Peyote Stitch

W/ROUND BEADS

ARTBEADS SEED BEAD GRAPH PAPER / HOORAY FOR HANDMADE!



Student Assessment Plan

Students' final assessment will be the finished products of each lesson as indicated after each lesson plan.

Alignment with Standards

Because students participating in this unit come from a variety of grade levels, this unit addresses the following Arizona mathematics content standards:

6th grade Az Math Standards - Geometry (G)

- 6.G.A.3: Draw polygons in the coordinate plane given coordinates for the vertices; use coordinates to find the length of a side joining points with the same first coordinate or the same second coordinate. Apply these techniques to solve mathematical problems and problems in a real-world context.

7th grade Az Math Standards - Geometry (G)

- 7.G.A Draw, construct, and describe geometrical figures, and describe the relationships between them.
- 7.G.A.1: Solve problems involving scale drawings of geometric figures, such as computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.

8th grade Az Math Standards - Geometry (G)

- 8.G.A Understand congruence and similarity.
- 8.G.A.3: Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.
- 8.G.A.3: Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.

The unit also addresses several Diné cultural standards, especially in grades 4-6:

Standard: K'4 d00 nits1h1kees d00 nahat'1 n11sg00 iin1 bee siih hasingo 1dooln77[.

I will develop an understanding of Diné way of life.

Concept 1- Nits1h1kees

Shinits1h1kees shi[nil98go bee 1daa 1konisdzin doolee[.

I will acknowledge and value my thoughts and personality.

- PO 2. Y0d7 a[taas'47 choosh'7n7g77 baa h33h nisin d00 baa 1h1shy32 doolee[.
I will organize and keep track of my personal belongings
- PO 3. Nit['iz a[taas'47 baa 1konisin d00 baa hashne'doolee[.
I will explain the significance of my cultural possessions.

Resources

“Native American Beadwork” (<https://www.kshs.org/kansapedia/Native-american-beadwork/17880>)

“Native American Beadwork | Traditional Beading History, Patterns & Styles”
(<https://www.powwows.com/Native-american-beadwork-a-rich-history-of-cultural-techniques/>)

<https://artbeads.com/printable-seed-bead-graph-paper-free-designer-download/>

<https://csdt.org/culture/beadloom/index.html>

<https://www.interweave.com/article/beading/how-to-peyote-stitch/>

Barta, J. & Eglash, Ron. (2009). Teaching artful expressions of mathematical beauty: Virtually creating Native American beadwork and rug weaving. 10.4018/978-1-60566-352-4.ch016.

Barkley, Cathy A., and Sandra Cruz. "Geometry through Beadwork Designs." *Teaching Children Mathematics*, vol. 7, no. 6, 2001, p. 362. *Gale Academic OneFile*, link.gale.com/apps/doc/A70651559/AONE?u=azstatelibdev&sid=AONE&xid=2bdfc34c. Accessed 3 May 2021.

Haley Lewis - Published on Apr 08, Author Portrait Image Haley Lewis Description Haley *How beading is helping these students learn about mathematical concepts - and Indigenous culture*. TVO.org. 2021, from <https://www.tvo.org/article/how-beading-is-helping-these-students-learn-about-mathematical-concepts-and-indigenous-culture>

Sohn, E. (2020, January 3). *Math of the world*. Science News for Students. Retrieved December 17, 2021, from <https://www.sciencenewsforstudents.org/article/math-world>